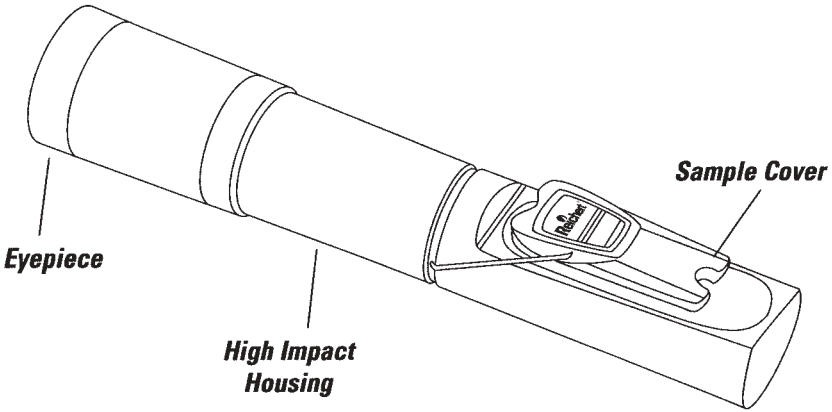
REICHERT TS METER Refractometer

Model 1310400A

Total Solids Refractometer



Instruction Manual

Reichert®

Reichert TS-METER Total Solids Refractometer Model 1310400A

Instruction Manual

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1.0 INTRODUCTION

The REICHERT TS METER Model 1310400A Total Solids Refractometer has been designed for simple, rapid microanalysis in biomedical, chemistry and classroom laboratories. The determination of concentrations of solutions is one of the oldest uses of refractometry. The TS METER Refractometer offers unprecedented simplicity of application, lending itself to checks and controls of many laboratory reagents, preparations, pharmaceuticals and specimens.

Scales are calibrated for protein concentration of plasma or serum (grams/100mL) and specific gravity of urine and refractive index Determinations are precise and rapid and require only a drop of fluid sample. The value on the appropriate scale seen through the eyepiece, is read where the sharp boundary between dark and light fields crosses the scale. The instruments are temperature compensated for temperatures between 60°F (16°C) and 100°F (38°C). The reading does not need to be adjusted for the sample or ambient temperature.

The accuracy of the determination of total solids–or water–in plasma and urine from measurement of refractive index, and for the measurement of specific gravity of urine from refractive index, has been well documented.[1,2,3,20] The estimation of plasma or serum protein concentration by refractometry has also been advocated for many years.[4-9] The accuracy of this determination is satisfactory for clinical use although it is not as reliable as the measurement of total solids and of specific gravity.

2.0 OPERATING INSTRUCTIONS

Hold the instrument in a horizontal position. To minimize evaporation place the cover plate over the measuring prism, then place the sample liquid on the exposed top or bottom of the measuring prism. The liquid will be drawn into the space between the prism and the cover plate by capillary action. Take care to avoid lifting the cover plate before the reading is made. A dropper may be used to transfer the sample to the measuring prism. The dropper should be plastic to minimize the possibility of scratching the prism surface.

Alternately, the instrument may be loaded by swinging the cover plate over the body of the instrument to expose the prism and the cover plate surfaces. A small sample is then placed on the measuring prism. To minimize evaporation, close the cover plate over the measuring prism immediately.

To hold the instrument for reading, place your middle finger on nameplate and press the plastic cover gently, but firmly. This spreads the sample in a thin, even layer over the prism. Point the instrument toward a bright window or other source of illumination, such as a lamp. It can also be placed on

a specially designed illuminated refractometer table stand. To obtain the optimum contrast between light and dark boundary, the instrument must be properly tilted toward the window or light source. Increased contrast and sharpness of the boundary may be obtained by using a vertical, gold color fluorescent lamp.

Focus the scale seen in the eyepiece by rotating the eyepiece. This setting does not need to be changed as long as the same individual continues to use the instrument.

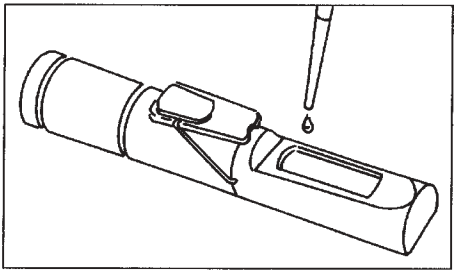
Read the appropriate scale at the point where the dividing line between bright and dark fields cross. Use the conversion tables in this manual, (pages 9-14), if required.

Use a soft cloth or tissue moistened with water to wipe the prism and dry thoroughly. If the prism surface or cover plate is not cleaned before the next sample is loaded, an erroneous or fuzzy reading may result. Do not immerse the eyepiece or the black focusing ring in water and do not use hot water. Never use gritty cleaning compounds to clean the prism. ***WARNING:*** *Never expose the instrument to temperatures above 150°F (60°C).*

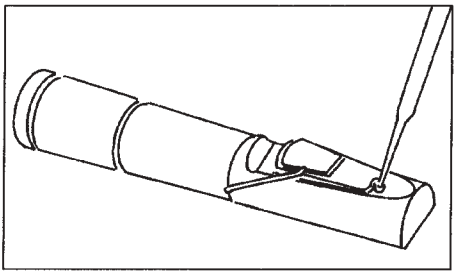
3.0 ZERO SETTING

The zero setting of the TS METER Refractometer rarely needs adjustment. In order to check adjustment make sure the temperature of the instrument is between 70°F (21°C) and 85°F (29°C) and take a reading on distilled water as explained previously. If a reading departs from zero by more than .05% (1/2 division) gently pry through the cement prism seal and turn the adjustment screw, with the appropriate tool, clockwise to increase the reading, counter-clockwise to decrease it. Make sure that final motion is clockwise. **Seal the hole with caulking compound after correct reading has been obtained.**

NOTE: *Caulking compound is supplied with the instrument.*



1. Place a drop or two of sample on the prism, close the cover and aim toward a light source or



2. Place a drop of sample in the cover hole. Through capillary action it will disperse. Aim towards a light source to take reading.

4.0 TEMPERATURE COMPENSATION

The actual physical quantity measured by the TS METER is refractive index. The TS METER's scales show this value as specific gravity, protein concentration and refraction. The relationship between refractive index and the quantity used is derived from an analysis of published and unpublished experimental data. Since refractive index changes appreciably with temperature, the conversion formulas are valid at a standard temperature only.

The TS METER Refractometer is temperature compensated to give correct readings directly on aqueous solutions at all temperatures ranging from 60°F (16°C) to 100°F (38°C). The maximum error at the extremes of the instrument and temperature ranges is 0.1% but the actual error over the most useful portion is much less, as shown in Figure 3. The largest error occurs at the lowest scale readings, and particularly with pure water at temperatures of 65°F (18°C) and below. If water is used for calibration, the temperature should be 70°F (21°C) or above.

The TS METER Refractometer, provides temperature compensation and reads solid standards correctly only at temperatures between 65°F (18°C) and 70°F (21°C).

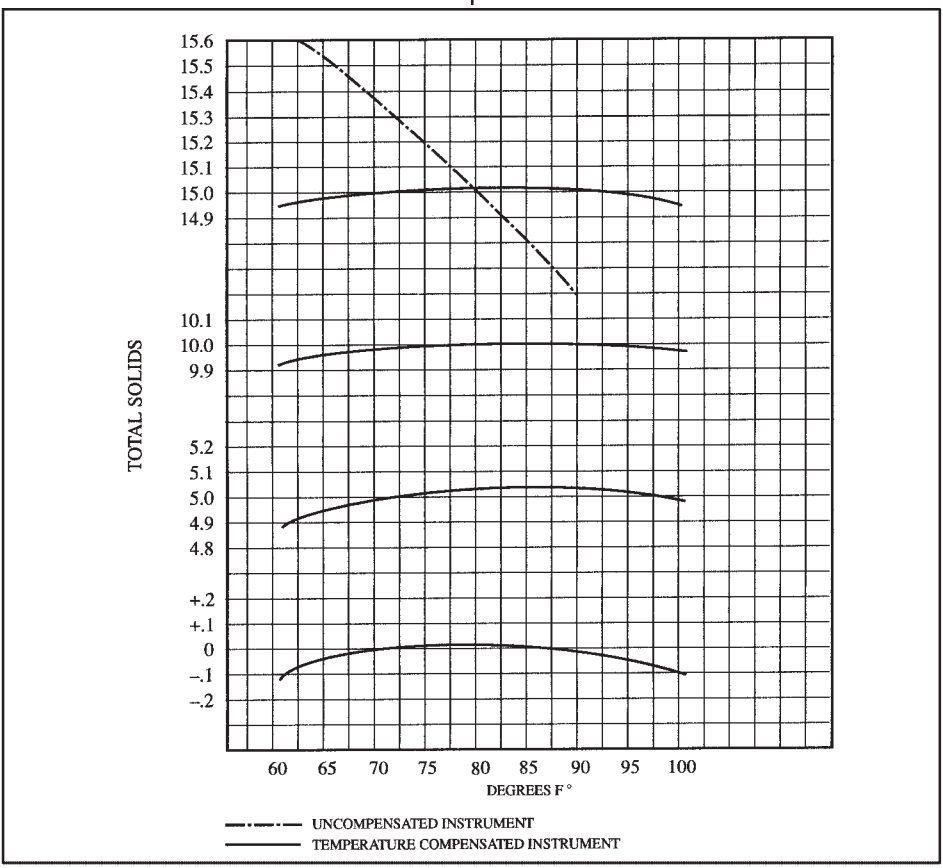


Figure 3 Temperature response of Model 1310400A TS METER

5.0 DIPPING REFRACTOMETRY

To obtain a sharp shadow line and best possible compensation, the refractometer prism must be in temperature equilibrium with the sample to be measured or a sharp shadow line will not be produced. No special precautions are required if the sample is small because it will equilibriate to the instrument's temperature immediately. However, if the refractometer is used as a dipping instrument, three to five minutes should be allowed if the temperature of the solution differs substantially from that of the instrument.

WARNING: *It is extremely important that the hole of the zero setting screw be well caulked so that fluids do not enter and damage the instrument when immersed or when being washed. Use caulking compound supplied with the instrument.*

6.0 AIR BUBBLE

Temperature compensation is produced with optical action of a liquid filled cavity arranged in the optical path. This cavity is hermetically sealed and cannot leak.

Thermal expansion of the liquid is accommodated with an air bubble which is kept out of the optical path by a bubble trap placed at the end of the cavity. In transit or under severe vibration, the bubble may escape the trap and appear in the visible portion of the refractometer prism. If this occurs, the instrument should be held vertically, eyepiece down, and shaken lightly. This will allow the bubble to pass into the trap where it will be held during all normal operations.

7.0 NON-AQUEOUS SOLUTIONS

The TS METER is temperature compensated for aqueous solutions. The refractive index temperature coefficient refractive index of oils, hydrocarbons or other liquid products is generally larger than that of water. Precautions should thus be taken if materials other than aqueous solutions are measured.

At temperatures between 65°F (18°C) and 70°F (21°C), the reading will generally be correct for all products. Above and below this range there will be an error in the same direction as that produced with the conventional, uncompensated type of refractometers, but of about half the magnitude. The temperature correction necessary for specific non-aqueous solutions will be furnished upon request.

8.0 USE OF TS METER REFRACTOMETER CONVERSION TABLES

If using the direct reading scales in the instrument and the conversion tables in this manual, (pages 9-14), remember that these measurements are specific for two types: plasma/serum and urine. The scales are NOT a valid measure of other samples without conversion.

9.0 SERUM TOTAL SOLIDS AND WATER MEASUREMENTS: SERUM AND URINE SOLUTE CONCENTRATIONS BASED UPON WATER

The convenience of estimating serum total solids with the TS METER Refractometer makes it useful not merely as an absolute and comparative measure of solids, but also as a measure of serum water. The concentration of water in serum (g/100 mL) and percent water in serum (g/100 mL) are given in the conversion table. Individual solute concentrations are readily converted from a serum to a serum water base; e.g., serum sodium, 146mEq/L of serum; TS METER reading, 9.0%; water concentration (from conversion table), 93.3 gm/100 mL or .933 kg/mL; and 146/.933 = 156 mEq of sodium/kg of serum water. If desired, the concentration of sodium in extra-cellular fluid, corrected for Donnan ratio, can be found from 156 x 0.95 = 148 mEq of sodium/kg of water of extracellular fluid.

Similarly, the conversion tables shown at the end of this manual can help you determine urinary water as a percent or as concentration; e.g., urine reading on the specific gravity scale, 1.035; actual urine solids, 8.5%; urine water, 91.5 gm/100 gm or 94.5 gm/100 mL.

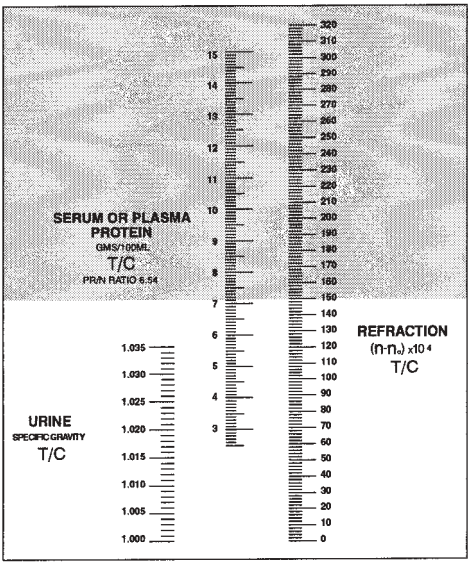


Figure 4

10.0 ESTIMATION OF PROTEIN BY REFRACTOMETRY

Although it is practical for many purposes to estimate total serum protein by refractometric methods, certain points should be kept in mind.

Measurement of serum protein depends on the high correlation between refraction and total solids. In the computation of the table, the two non-protein solids fractions are considered: ultrafiltrates proportional to water concentration, and lipids (and other high molecular weight compounds proportional to the protein concentration). Total non-protein solids is the sum of these two fractions. While the accuracy of estimate of total solids is approximately ±.1 gm%, that of protein may be somewhat less[7] This follows from the variability of concentration of such serum solutes as glucose, urea, salts and lipids, especially in certain disease states.[8]

The TS METER Refractometer reticle and conversion tables (pages 9—14) are scaled primarily for the measurement of serum or plasma protein and must not be applied indiscriminately to other protein-containing solutions. Pure water set and read at scale zero is sufficient to check the TS METER since the instrument is itself standardized optically. If further testing is desired, it is advisable to use an aqueous solution whose refractive index is well known from concentrative conversion tables.[15,16]

The numerical relationship between refraction and total serum protein depends upon the factor used to convert human serum protein nitrogen to protein. The recommended factor, 6.54, provides values from protein concentration essentially consistent with serum total solids and nonprotein solids.[14,17]

Total protein in urine and certain other fluids can be measured refractometrically from the determination of total solids in the fluid before and after protein has been removed by heat.[9,18]

11.0 ESTIMATION OF SPECIFIC GRAVITY AND TOTAL SOLIDS OF URINE BY REFRACTOMETRY

In part because the TS METER Refractometer measures total solids in urine to an accuracy of ±.lgm %, and since it requires a change of ca. .25gm % in total solids to change specific gravity by ca. .001 units, optical urinometry is excellent for clinical measurement of specific gravity. The reticle of the TS METER Refractometer, and conversion tables (pages 9–14) are scaled for human urine. Few normal human urines exceed 1.035; much higher values suggest the presence of unusual solutes in the specimen which have high specific gravity increments per osmol (e.g., glucose, sucrose, protein, radiopaque iodine compounds, sodium sulfate, etc.). Because refraction correlates relatively poorly with specific gravity, in contrast to total solids in solutions of variable composition, especially at high concentrations, refractometric readings will not provide reliable extrapolation of urine specific gravity to values in excess of 1.035. Such extrapolation is particularly not advised in animals which may produce exceedingly hypergravic and hypersteric urines. Urinary total solids or the refractive index difference as a measure of absolute and relative concentration is a preferred method.

If human urine being analyzed is hypogravic (specific gravity less than 1.017) under concentration test, estimation of specific gravity by refractometric means is exceptionally accurate, regardless of variation in relative composition (e.g., salt, urea). As a clinical measure of such renal dysfunction, therefore, optical urinometry is an excellent diagnostic tool. With progressive renal failure, diverse measures of urinary concentration such as osmolality, total solids, specific gravity, and refraction converge to narrow ranges which are similarly pathognomonic.[19] The fact that these measures diverge in the maximally concentrated urine of normal individuals has no bearing on pathologic or diagnostic significance.

12.0 ESTIMATION OF CONCENTRTION OF OTHER BODY FLUIDS AND OF PURE SOLUTIONS

Fluids such as pancreatic juice, saliva and prostatic fluid may also be analyzed refractometrically. However, interpretation of such refractions should not be made without reference to suitable standardization; it may be inappropriate to use the TS METER scale of serum directly for this purpose.[20]

13.0 REFRACTION SCALE

The refraction or refractive index difference scale (0-320) allows a check of a single solute concentration to be made in seconds.

Extensive data is given in the Manual "Tables of Properties of Aqueous Solutions Related to Index of Refraction,"[16] (Cat. No. 10403), that tabulates the refraction of particular aqueous solutions against osmotic pressure, specific gravity, molarity, solute concentration and water concentration.

In addition, graphs for other solutions can be prepared by plotting points for several known concentrations against refraction.

14.0 INFORMATION OBTAINABLE WITH THE REICHERT TS METER

PLASMA OR SERUM, 68°F (20°C).

1. **Total Solids % Composition by Weight,** (TS%). Read instrument scale of protein and use Conversion Table.

2. **Water % Composition by Weight,** (Water %). Subtract total solids % composition above from 100%.

3. **Total Solids Concentration,** grams 100mL., 68°F (20°C), (C_{TS},g/100mL). Read instrument scale and use Conversion Table.

4. **Water Concentration,** grams/100mL, 68°F (20°C), (C_W, g/100mL). Read instrument scale and use Conversion Table.

5. **Specific Gravity,** 68°F (20°C), ($D_{20/20}$ sp. g). Read instrument scale and use Conversion Table.

6. **Protein Concentration,** grams/100mL, 68°F (20°C), (C_{PR}, g/100mL). Direct scale reading with TS Meter.

7. **Concentration Total Solids** relative to water ($C_{TS} \div C_W$, x 10^2 = grams/100g water).

REFRACTIVE INDEX, 20°C. (REFRACTIVE INDEX AND REFRACTION)

1. **Refractive Index, (n),** of aqueous or other solutions, 68°F (20°C). With the TS Meter read the instrument scale and use the Conversion Table.

2. **Refractive Index Difference x 10^4,** between aqueous solutions and water, 68°F (20°C), also called Refraction, r = (n - 1.3330) 104. Direct scale reading with TS Meter.

3. **Concentrative Properties** of aqueous, such as % composition, Concentration, Specific Gravity, Freezing Point Depression, Viscosity and Electrical Conductivity may be obtained with special Concentrative, Conversion Tables Based upon refractive index and refraction. Direct scale reading of refraction with TS METER.

URINE, 68°F (20°C).

1. **Specific Gravity,** 68°F (20°C), ($D_{20/20}$ sp. g). Direct scale reading, TS Meter.

2. **Total Solids % Composition by Weight,** (TS%). Read instrument scale and use Conversion Table.

3. **Water % Composition by Weight,** (Water %). Subtract total solids % composition above from 100%.

4. **Total Solids Concentration,** grams/100mL, 68°F (20°C), (C_{TS}, g/100mL). Read instrument scale and use Conversion Table.

5. **Water Concentration,** grams/100mL, 68°F (20°C), (C_W, g/100ml.). Read instrument scale and use Conversion Table.

6. **Concentration Total Solids** relative to water ($C_{TS} = C_W$ X 10^2 = grams/100g water).

Notes: C=Concentration, TS=Total Solids, W=Water, Pr=Protein, NPr=Non-Protein Solids
Protein concentrations have been determined as differences between non-protein solids and total solids.
These protein concentrations are consistent with a Pr/N ratio of 6.54.

PLASMA OR SERUM, 20°C.							REFRACTIVE INDEX 20°C.		URINE SOLIDS, 20°C.				
D20/20	C_{TS}	C_W	C_{TS}/C_W x10^2	C_{NPr}	TS%	* C_{Pr}	* (n-no) x10^4	n	* D20/20	TS%	C_{TS}	C_W	C_{TS}/C_W x10^2
sp.gr.	g/100 ml.	g/100 ml.	g/100 g	g/100 ml.	by wt.	g/100 ml.			sp.gr.	by wt.	g/100 ml.	g/100 ml.	g/100 g
							0	1.3330	1.000	0.0	0.0	99.8	0.00
							2	1.3332	1.001	0.1	0.1	99.8	0.1
							4	1.3334	1.001	0.2	0.2	99.7	0.2
							6	1.3336	1.002	0.4	0.4	99.6	0.4
							8	1.3338	1.002	0.5	0.5	99.6	0.5
							10	1.3340	1.003	0.6	0.6	99.5	0.6
							12	1.3342	1.004	0.7	0.7	99.4	0.7
							14	1.3344	1.004	0.9	0.9	99.4	0.9
							16	1.3346	1.005	1.0	1.0	99.3	1.0
1.0072	1.0	99.5	1.0	1.00	1.0		18	1.3348,	1.005	1.1	1.1	99.2	1.1
1.0075	1.1	99.5	1.1	1.01	1.1		20	1.3350	1.006	1.2	1.2	99.2	1.3
1.0078	1.2	99.4	1.2	1.02	1.2		22	1.3352	1.006	1.4	1.4	99.1	1.4
1.0080	1.3	99.3	1.3	1.02	1.3		24	1.3354	1.007	1.5	1.5	99.0	1.5
1.0083	1.4	99.2	1.5	1.03	1.4		26	1.3356	1.008	1.6	1.6	99.0	1.6
1.0086	1.6	99.1	1.6	1.04	1.5		28	1.3358	1.008	1.7	1.8	98.9	1.8
1.0088	1.7	99.0	1.7	1.05	1.6		30	1.3360	1.009	1.9	1.9	98.8	1.9
1.0091	1.8	99.0	1.8	1.06	1.8		32	1.3362	1.009	2.0	2.0	98.7	2.0
1.0094	1.9	98.9	1.9	1.06	1.9		34	1.3364	1.010	2.1	2.2	98.7	2.2
1.0096	2.0	98.8	2.0	1.07	2.0		36	1.3366	1.010	2.3	2.3	98.6	2.3
1.0099	2.1	98.7	2.1	1.08	2.1		38	1.3368	1.011	2.4	2.4	98.5	2.4
1.0102	2.2	98.6	2.2	1.09	2.2		40	1.3370	1.012	2.5	2.5	98.4	2.6
1.0104	2.3	98.5	2.4	1.09	2.3		42	1.3372	1.012	2.7	2.7	98.4	2.7
1.0107	2.4	98.5	2.5	1.10	2.4		44	1.3374	1.013	2.8	2.8	98.3	2.9
1.0110	2.5	98.4	2.6	1.11	2.5		46	1.3376	1.013	2.9	2.9	98.2	3.0
1.0112	2.7	98.3	2.7	1.12	2.6		48	1.3378	1.014	3.0	3.1	98.1	3.1

PLASMA OR SERUM, 20°C.							REFRACTIVE INDEX 20°C.		URINE SOLIDS, 20°C.				
D20/20 sp.gr.	C_{TS} g/100 ml.	C_W g/100 ml.	C_{TS}/C_W x10² g/100 g	C_{NPr} g/100 ml.	TS% by wt.	* C_{Pr} g/100 ml.	* (n-no) x10⁴	n	* D20/20 sp.gr.	TS% by wt.	C_{TS} g/100 ml.	C_W g/100 ml.	C_{TS}/C_W x10² g/100 g
1.0112	2.7	98.3	2.7	1.12	2.6		48	1.3378	1.014	3.0	3.1	98.1	3.1
1.0115	2.8	98.2	2.8	1.13	2.7		50	1.3380	1.014	3.2	3.2	98.0	3.3
1.0117	2.9	98.1	2.9	1.13	2.8		52	1.3382	1.015	3.3	3.3	98.0	3.4
1.0120	3.0	98.0	3.0	1.14	3.0		54	1.3384	1.015	3.4	3.5	97.9	3.6
1.0123	3.1	97.9	3.2	1.15	3.1		56	1.3386	1.016	3.6	3.6	97.8	3.7
1.0125	3.2	97.9	3.3	1.16	3.2		58	1.3388	1.017	3.7	3.8	97.7	3.8
1.0128	3.3	97.8	3.4	1.17	3.3		60	1.3390	1.017	3.8	3.9	97.6	4.0
1.0131	3.4	97.7	3.5	1.17	3.4		62	1.3392	1.018	4.0	4.0	97.6	4.1
1.0133	3.5	97.6	3.6	1.18	3.5		64	1.3394	1.018	4.1	4.2	97.5	4.3
1.0136	3.7	97.5	3.7	1.19	3.6	2.5	66	1.3396	1.019	4.2	4.3	97.4	4.4
1.0139	3.8	97.4	3.9	1.20	3.7	2.6	68	1.3398	1.019	4.4	4.4	97.3	4.6
1.0141	3.9	97.4	4.0	1.21	3.8	2.7	70	1.3400	1.020	4.5	4.6	97.2	4.7
1.0144	4.0	97.3	4.1	1.21	3.9	2.8	72	1.3402	1.020	4.6	4.7	97.1	4.8
1.0147	4.4	97.2	4.2	1.22	4.0	2.9	74	1.3404	1.021	4.8	4.8	97.1	5.0
1.0149	4.2	97.1	4.3	1.23	4.2	3.0	76	1.3406	1.021	4.9	5.0	97.0	5.1
1.0152	4.3	97	4.5	1.24	4.3	3.1	78	1.3408	1.022	5	5.1	96.9	5.3
1.0155	4.4	96.9	4.6	1.25	4.4	3.5	80	1.3410	1.022	5.1	5.3	96.8	5.4
1.0157	4.5	96.8	4.7	1.25	4.5	3.3	82	1.3412	1.023	5.3	5.4	96.7	5.6
1.0160	4.7	96.8	4.8	1.26	4.6	3.4	84	1.3414	1.023	5.4	5.5	96.6	5.7
1.0163	4.8	96.7	4.9	1.27	4.7	3.5	86	1.3416	1.024	5.5	5.7	96.5	5.9
1.0165	4.9	96.6	5.1	1.28	4.8	3.6	88	1.3418	1.024	5.7	5.8	96.4	6.0
1.0168	5.0	96.5	5.2	1.29	4.9	3.7	90	1.3420	1.025	5.8	5.9	96.4	6.2
1.0171	5.1	96.4	5.3	1.29	5.0	3.8	92	1.3422	1.025	5.9	6.1	96.3	6.3
1.0173	5.2	96.3	5.4	1.30	5.1	3.9	94	1.3424	1.026	6.1	6.2	96.2	6.5
1.0176	5.3	96.3	5.5	1.31	5.2	4.0	96	1.3426	1.026	6.2	6.4	96.1	6.6
1.0179	5.4	96.2	5.7	1.32	5.4	4.1	98	1.3428	1.027	6.3	6.5	96.0	6.8
1.0181	5.6	96.1	5.8	1.33	5.5	4.2	100	1.3430	1.027	6.5	6.6	95.9	6.9

PLASMA OR SERUM, 20°C.							REFRACTIVE INDEX 20°C.		URINE SOLIDS, 20°C.				
D20/20	C_{TS}	C_W	C_{TS}/C_W x10^2	C_{NPr}	TS%	* C_{Pr}	* (n-no) x10^4	n	* D20/20	TS%	C_{TS}	C_W	C_{TS}/C_W x10^2
sp.gr.	g/100 ml.	g/100 ml.	g/100 g	g/100 ml.	by wt.	g/100 ml.			sp.gr.	by wt.	g/100 ml.	g/100 ml.	g/100 g
1.0181	5.6	96.1	5.8	1.33	5.5	4.2	100	1.3430	1.027	6.5	6.6	95.9	6.9
1.0184	5.7	96.0	5.9	1.34	5.6	4.3	102	1.3432	1.028	6.6	6.8	95.8	7.1
1.0187	5.8	95.9	6	1.34	5.7	4.4	104	1.3434	1.028	6.7	6.9	95.7	7.2
1.0189	5.9	95.8	6.1	1.35	5.8	4.5	106	1.3436	1.029	6.9	7.0	95.6	7.4
1.0192	6.0	95.7	6.3	1.36	5.9	4.6	108	1.3438	1.029	7.0	7.2	95.5	7.5
1.0195	6.1	95.7	6.4	1.37	6.0	4.7	110	1.3440	1.030	7.1	7.3	95.5	7.7
1.0197	6.2	95.6	6.5	1.38	6.1	4.8	112	1.3442	1.030	7.3	7.5	95.4	7.8
1.0200	6.3	95.5	6.6	1.38	6.2	5.0	114	1.3444	1.031	7.4	7.6	95.3	8.0
1.0203	6.4	95.4	6.8	1.39	6.3	5.1	116	1.3446	1.031	7.5	7.7	95.2	8.1
1.0205	6.6	95.3	6.9	1.40	6.4	5.2	118	1.3448	1.032	7.7	7.9	95.1	8.3
1.0208	6.7	95.2	7.0	1.41	6.5	5.3	120	1.3450	1.032	7.8	8.0	95.0	8.4
1.0211	6.8	95.1	7.1	1.42	6.7	5.4	122	1.3452	1.032	7.9	8.2	94.9	8.6
1.0213	6.9	95.1	7.3	1.42	6.8	5.5	124	1.3454	1.033	8.0	8.3	94.8	8.7
1.0216	7.0	95.0	7.4	1.43	6.9	5.6	126	1.3456	1.033	8.2	8.4	94.7	8.9
1.0219	7.1	94.9	7.5	1.44	7.0	5.7	128	1.3458	1.034	8.3	8.6	94.6	9.1
1.0221	7.2	94.8	7.6	1.45	7.1	5.8	130	1.3460	1.034	8.4	8.7	94.5	9.2
1.0224	7.3	94.7	7.8	1.46	7.2	5.9	132	1.3462	1.035	8.6	8.8	94.4	9.4
1.0227	7.5	94.6	7.9	1.46	7.3	6.0	134	1.3464	1.035	8.7	9.0	94.4	9.5
1.0229	7.6	94.5	8.0	1.47	7.4	6.1	136	1.3466	1.036	8.8	9.1	94.3	9.7
1.0232	7.7	94.5	8.1	1.48	7.5	6.2	138	1.3468	1.036	9.0	9.3	94.2	9.8
1.0235	7.8	94.4	8.3	1.49	7.6	6.3	140	1.3470	1.037	9.1	9.4	94.1	10.0
1.0237	7.9	94.3	8.4	1.50	7.7	6.4	142	1.3472	1.037	9.2	9.5	94.0	10.1
1.0240	8.0	94.2	8.5	1.50	7.8	6.5	144	1.3474	1.037	9.3	9.7	93.9	10.3
1.0243	8.1	94.1	8.6	1.51	8.0	6.6	146	1.3476	1.038	9.5	9.8	93.8	10.5
1.0245	8.2	94.0	8.8	1.52	8.1	6.7	148	1.3478	1.038	9.6	9.9	93.7	10.6
1.0248	8.4	93.9	8.9	1.53	8.2	6.8	150	1.3480	1.039	9.7	10.1	93.6	10.8

PLASMA OR SERUM, 20°C.							REFRACTIVE INDEX 20°C.		URINE SOLIDS, 20°C.				
D20/20 sp.gr.	C_{TS} g/100 ml.	C_W g/100 ml.	C_{TS}/C_W x10^2 g/100 g	C_{NPr} g/100 ml.	TS% by wt.	* C_{Pr} g/100 ml.	* (n-no) x10^4	n	* D20/20 sp.gr.	TS% by wt.	C_{TS} g/100 ml.	C_W g/100 ml.	C_{TS}/C_W x10^2 g/100 g
1.0248	8.4	93.9	8.9	1.53	8.2	6.8	150	1.3480	1.039	9.7	10.1	93.6	10.8
1.0251	8.5	93.9	9.0	1.54	8.3	6.9	152	1.3482	1.039	9.8	10.2	93.5	10.9
1.0254	8.6	93.8	9.2	1.55	8.4	7.0	154	1.3484	1.04	10.0	10.3	93.4	11.1
1.0256	8.7	93.7	9.3	1.55	8.5	7.1	156	1.3486	1.04	10.1	10.5	93.3	11.2
1.0259	8.8	93.6	9.4	1.56	8.6	7.2	158	1.3488	1.04	10.2	10.6	93.2	11.4
1.0262	8.9	93.5	9.5	1.57	8.7	7.4	160	1.3490					
1.0264	9.0	93.4	9.7	1.58	8.8	7.5	162	1.3492					
1.0267	9.1	93.3	9.8	1.59	8.9	7.6	164	1.3494					
1.0270	9.3	93.3	9.9	1.59	9.0	7.7	166	1.3496					
1.0272	9.4	93.2	10.1	1.60	9.1	7.8	168	1.3498					
1.0275	9.5	93.1	10.2	1.61	9.2	7.9	170	1.3500					
1.0278	9.6	93.0	10.3	1.62	9.4	8.0	172	1.3502					
1.0281	9.7	92.9	10.4	1.63	9.5	8.1	174	1.3504					
1.0283	9.8	92.8	10.6	1.63	9.6	8.2	176	1.3506					
1.0286	9.9	92.7	10.7	1.64	9.7	8.3	178	1.3508					
1.0289	10.0	92.7	10.8	1.65	9.8	8.4	180	1.3510					
1.0291	10.2	92.6	11.0	1.66	9.9	8.5	182	1.3512					
1.0294	10.3	92.5	11.1	1.67	10.0	8.6	184	1.3514					
1.0297	10.4	92.4	11.5	1.67	10.1	8.7	186	1.3516					
1.0300	10.5	92.3	11.4	1.68	10.2	8.8	188	1.3518					
1.0302	10.6	92.2	11.5	1.69	10.3	8.9	190	1.3520					
1.0305	10.7	92.1	11.6	1.70	10.4	9.0	192	1.3522					
1.0308	10.8	92.1	11.8	1.71	10.5	9.1	194	1.3524					
1.0311	10.9	92.0	11.9	1.72	10.6	9.2	196	1.3526					
1.0313	11.1	91.9	12.0	1.72	10.7	9.3	198	1.3528					
1.0316	11.2	91.8	12.2	1.73	10.8	9.4	200	1.3530					

PLASMA OR SERUM, 20°C.							REFRACTIVE INDEX 20°C.		URINE SOLIDS, 20°C.				
D20/20 sp.gr.	C_{TS} g/100 ml.	C_W g/100 ml.	C_{TS}/C_W x10^2 g/100 g	C_{NPr} g/100 ml.	TS% by wt.	* C_{Pr} g/100 ml.	* (n-no) x10^4	n	* D20/20 sp.gr.	TS% by wt.	C_{TS} g/100 ml.	C_W g/100 ml.	C_{TS}/C_W x10^2 g/100 g
1.0316	11.2	91.8	12.2	1.73	10.8	9.4	200	1.3530					
1.0319	11.3	91.7	12.3	1.74	11.0	9.5	202	1.3532					
1.0322	11.4	91.6	12.4	1.75	11.1	9.6	204	1.3534					
1.0324	11.5	91.6	12.6	1.76	11.2	9.8	206	1.3536					
1.0327	11.6	91.5	12.7	1.76	11.3	9.9	208	1.3538					
1.0330	11.7	91.4	12.8	1.77	11.4	10.0	210	1.3540					
1.0333	11.8	91.3	13.0	1.78	11.5	10.1	212	1.3542					
1.0335	12.0	91.2	13.1	1.79	11.6	10.2	214	1.3544					
1.0338	12.1	91.1	13.2	1.80	11.7	10.3	216	1.3546					
1.0341	12.2	91.0	13.4	1.80	11.8	10.4	218	1.3548					
1.0344	12.3	91.0	13.5	1.81	11.9	10.5	220	1.3550					
1.0346	12.4	90.9	13.7	1.82	12.0	10.6	222	1.3552					
1.0349	12.5	90.8	13.8	1.83	12.1	10.7	224	1.3554					
1.0352	12.6	90.7	13.9	1.84	12.2	10.8	226	1.3556					
1.0355	12.7	90.6	14.1	1.84	12.3	10.9	228	1.3558					
1.0357	12.9	90.5	14.2	1.85	12.4	11.0	230	1.3560					
1.0360	13.0	90.4	14.3	1.86	12.5	11.1	232	1.3562					
1.0363	13.1	90.4	14.5	1.87	12.6	11,2	234	1.3564					
1.0366	13.2	90.3	14.6	1.88	12.8	11.3	236	1.3566					
1.0369	13.3	90.2	14.8	1.89	12.9	11.4	238	1.3568					
1.0371	13.4	90.1	14.9	1.89	13.0	11.5	240	1.3570					
1.0374	13.5	90.0	15.0	1.90	13.1	11.6	242	1.3572					
1.0377	13.6	89.9	15.2	1.91	13.2	11.7	244	1.3574					
1.0380	13.8	89.9	15.3	1.92	13.3	11.8	246	1.3576					
1.0383	13.9	89.8	15.4	1.93	13.4	11.9	248	1.3578					
1.0385	14.0	89.7	15.6	1.93	13.5	12.0	250	1.3580					

PLASMA OR SERUM, 20°C.							REFRACTIVE INDEX 20°C.		URINE SOLIDS, 20°C.				
D20/20	C_{TS}	C_W	C_{TS}/C_W x10^2	C_{NPr}	TS%	* C_{Pr}	* (n-no) x10^4	n	* D20/20	TS%	C_{TS}	C_W	C_{TS}/C_W x10^2
sp.gr.	g/100 ml.	g/100 ml.	g/100 g	g/100 ml.	by wt.	g/100 ml.			sp.gr.	by wt.	g/100 ml.	g/100 ml.	g/100 g
1.0385	14.0	89.7	15.6	1.93	13.5	12.0	250	1.3580					
1.0388	14.1	89.6	15.7	1.94	13.6	12.2	252	1.3582					
1.0391	14.2	89.5	15.9	1.95	13.7	12.3	254	1.3584					
1.0394	14.3	89.4	16.0	1.96	13.8	12.4	256	1.3586					
1.0397	14.4	89.4	16.1	1.97	13.9	12.5	258	1.3588					
1.0399	14.5	89.3	16.3	1.97	14.0	12.6	260	1.3590					
1.0402	14.7	89.2	16.4	1.98	14.1	12.7	262	1.3592					
1.0405	14.8	89.1	16.6	1.99	14.2	12.8	264	1.3594					
1.0408	14.9	89.0	16.7	2.00	14.3	12.9	266	1.3596					
1.0411	15.0	88.9	16.9	2.01	14.4	13.0	268	1.3598					
1.0414	15.1	88.9	17.0	2.01	14.5	13.1	270	1.3600					
1.0416	15.2	88.8	17.1	2.02	14.6	13.2	272	1.3602					
1.0419	15.3	88.7	17.3	2.03	14.7	13.3	274	1.3604					
1.0422	15.4	88.6	17.4	2.04	14.8	13.4	276	1.3606					
1.0425	15.5	88.5	17.6	2.05	14.9	13.5	278	1.3608					
1.0428	15.7	88.4	17.7	2.05	15.0	13.6	280	1.3610					
1.0431	15.8	88.4	17.8	2.06	15.1	13.7	282	1.3612					
1.0433	15.9	88.3	18.0	2.07	15.2	13.8	284	1.3614					
1.0436	16.0	88.2	18.1	2.08	15.3	13.9	286	1.3616					
1.0439	16.1	88.1	18.3	2.09	15.5	14.0	288	1.3618					
1.0442	16.2	88.0	18.4	2.09	15.6	14.1	290	1.3620					
1.0445	16.3	87.9	18.6	2.10	15.7	14.2	292	1.3622					
1.0448	16.4	87.9	18.7	2.11	15.8	14.3	294	1.3624					
1.0451	16.5	87.8	18.9	2.12	15.9	14.4	296	1.3626					
1.0453	16.7	87.7	19.0	2.13	16.0	14.5	298	1.3628					
1.0456	16.8	87.6	19.1	2.13	16.1	14.6	300	1.3630					

Notes: C=Concentration, TS=Total Solids, W=Water, Pr=Protein, NPr=Non-Protein Solids
Protein concentrations have been determined as differences between non-protein solids and total solids.
These protein concentrations are consistent with a Pr/N ratio of 6.54.

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